(19) Japan Patent Office (JP)
(12) Publication of Patent Application (A)
(11) Japanese Patent Application Laid-open Number: Tokkai 2001-54165 (P2001-54165A)
(43) Laid-open Date: Heisei 13-2-23 (February 23, 2001)

(51) Int. Cl.[7]	Identification Code	FI		Theme Code (Reference)
	H04Q 7/38	H04B 7/26	109M	5K033
	H04L 12/28	H04L 11/00	310B	5K067

Request for Examination: Not Requested
Number of Claims: 10
OL (13 pages in total)
(21) Application Number: Tokugan-Hei 11-221795
(22) Filing Date: Heisei 11-8-4 (August 4, 1999)

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(54) [Title of the Invention] DEVICE, METHOD AND RECORDING MEDIUM FOR DATA COMMUNICATIONS

(57) [Abstract]
[Object] To provide a data communications device, which can distribute radio terminals to other base stations without requiring the radio terminals to perform special processing, and which can also improve the efficiency in using a radio medium.
[Solving Means] A transmission rate is set in a notice-information transmission-rate storing unit 13 from the outside. In this transmission rate, the selection status of a base

station is reflected. Upon receipt of notice information to be transmitted, a transmission-frame generating unit 11 processes the notice information so that the notice information forms a radio packet defined by the system. When what is to be transmitted is notice information, a transmission-rate controlling unit 12 acquires the transmission rate having been set in the notice-information transmission-rate storing unit 13, and then assigns the acquired transmission rate to a transmission processing unit 14 as a transmission rate of the notice information. The transmission processing unit 14 then broadcasts the notice information at the assigned transmission rate.

[Scope of Claims]

[Claim 1] A data communications device installed in a base station of a radio communications system configured so that each radio terminal can select, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal can be set as appropriate,

the data communications device characterized by comprising notice-information transmitting means which broadcasts the notice information at a transmission rate in which the selection status of the base station having the data communications device installed therein is reflected.

[Claim 2] The data communications device according to claim 1 characterized in that the notice-information transmitting means includes:

transmission-rate setting means which sets a transmission rate in which the selection status of the base station is reflected;

transmission-rate assigning means which acquires the transmission rate set by the transmission-rate setting means in a case where what is to be transmitted is the notice information, and which assigns the transmission rate thus acquired as a transmission rate for the notice information; and

transmitting means, which broadcasts the notice information at the transmission rate assigned by the transmission-rate assigning means.

[Claim 3] The data communications device according to claim 2 characterized by further comprising traffic measuring means which measures the number of radio packets received by the base station having the data communications device installed therein so as to measure the amount of traffic of the base station, and which then sets, in the transmission-rate setting means, a transmission rate depending on the current amount of traffic.

[Claim 4] The data communications device according to claim 2 characterized by

further comprising terminal monitoring means which monitors radio terminals each having selected, as an access point, the base station having the data communications device installed therein so as to find out the number of the radio terminals, and which then sets a transmission rate depending on the current number of the radio terminals in the transmission-rate setting means.

[Claim 5] The data communications device according to claim 2 characterized by further comprising notice-information monitoring means which monitors notice information transmitted from a neighboring base station so as to find out the transmission rate of the notice information, and which then sets a transmission rate depending on the current transmission rate thus found out in the transmission-rate setting means.

[Claim 6] A data communications method adopted by a base station of a radio communications system configured so that each radio terminal selects, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal is set as appropriate,

the data communications method characterized by comprising:

(a) a first step of setting a transmission rate in which the selection status of a base station adopting the data communications method is reflected;

(b) a second step of acquiring the transmission rate set in the first step in a case where what is to be transmitted is the notice information, and of then assigning the transmission rate thus acquired as a transmission rate for the notice information; and

(c) a third step of broadcasting the notice information at the transmission rate assigned in the second step.

[Claim 7] The data communications method according to claim 6 characterized in that, in the first step, the amount of traffic of the base station is measured by measuring the number of radio packets received by the base station adopting the data communications method, and a transmission rate depending on the current amount of traffic is then set

[Claim 8] The data communications method according to claim 6 characterized in that, in the first step, the number of the radio terminals is found out by monitoring radio terminals having selected, as an access point, the base station adopting the data communications method, and a transmission rate depending on the current number of the radio terminals is then set.

[Claim 9] The data communications method according to claim 6 characterized in

that, in the first step, the transmission rate of the notice information is found out by monitoring notice information transmitted from a neighboring base station, and a transmission rate depending on the current transmission rate is then set.

[Claim 10] A computer-readable recording medium having a program recorded therein, the program having a data communications method written therein, the data communications method adopted by a base station of a radio communications system configured so that each radio terminal selects, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal is set as appropriate, the program causing a computer to execute:

(a) a first step of setting a transmission rate in which the selection status of a base station adopting the data communications method is reflected;

(b) a second step of acquiring the transmission rate set in the first step in a case where what is to be transmitted is the notice information, and of then assigning the transmission rate thus acquired as a transmission rate for the notice information; and

(c) a third step of broadcasting the notice information at the transmission rate assigned in the second step.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Pertains] The present invention relates to a data communications device for a radio communication system in which a radio terminal receives notice information broadcasted from base stations so as to determine a base station to be used as an access point. In particular, the present invention relates to a data communications device, which is installed in a base station, and which is provided with a function of controlling a transmission rate of a notice information packet broadcasted to a radio terminal.

[0002]

[Prior Art] There has conventionally been a radio communications system that is configured so that a plurality of transmission rates can be used for radio packet communications between base stations and radio terminals. Such a system, in which a plurality of transmission rates can be used, can perform a fall back control allowing a base station to select the optimum transmission rate for communications with each radio terminal depending on a radio propagation environment, which changes from hour to hour, and thus to communicate with the radio terminals.

[0003] To be more precise, an increase in the transmission rate enables a high-speed

communications, and thus is preferable for users. However, in general, it is necessary that the radio propagation environment between stations be favorable and stable for performing communications with an increased transmission rate. On the other hand, when communications are performed with a decreased transmission rate, it is possible to adopt a radio transmission technique that is unlikely to be influenced by deterioration in the radio propagation environment even though the communication speed is decreased. This allows stable communication to be performed between a radio terminal and a base station even when the radio terminal is located far away from the base station. Accordingly, a transmission rate is set as appropriate depending on the radio propagation environment between the base station and each radio terminal, and then communications are performed between the station and the terminal. Consequently, the high-speed performance and stability of communications in the system as a whole are secured.

[0004] Here, the base station periodically broadcasts the own operational information as notice information packets to all the radio terminals. When the notice information is broadcasted, it is necessary that an unspecified number of radio terminals simultaneously receive the notice information. For this reason, the base station always uses a constant transmission rate for performing the broadcasting and transmits the notice information to each radio terminal at the same transmission rate. In general, as the transmission rate for the notice information, used is a transmission rate defined as the minimum communication speed that allows a radio terminal located in a position farthest therefrom to receive the notice information.

[0005] When the base stations broadcast the notice information packets, a radio terminal that wishes to access to the network selects a base station to be used as an access point. The radio terminal utilizes the notice information packets of the respective base stations as information for determining which base station should be selected. At this time, the radio terminal determines whether each base station is available, not only by using the content of the notice information, but also by using as a requirement for the determination, the reception status, such as the reception level of the packet. The radio terminal also selects a base station in a case where the reception status of the notice information packet of the base station having already been selected is deteriorated due to the movement of the radio terminal, or the like. The selecting operation in this case is generally called a handover.

[0006] Fig. 11 shows a configuration of a conventional data communications device, which is installed in a base station, and which transmits notice information and user data. Notice information or user data is inputted into a transmission-frame generating unit 11J

as data to be transmitted. The inputted data is processed by the transmission-frame generating unit 11J so as to form a radio packet defined by the system, and the processed radio packet is then inputted into a transmission processing unit 14J. The transmission-frame generating unit 11J also notifies a transmission-rate controlling unit 12J of the kind of the processed data (the notice information, the user data or the like) with a frame-kind notification signal S11J.

[0007] When the transmission-rate controlling unit 12J finds out, from the frame-kind notification signal S11J, that the data to be transmitted is user data to a radio terminal, the transmission-rate controlling unit 12J notifies the transmission processing unit 14J of a transmission rate having been preset as the optimum transmission rate for communications with each radio terminal as described above, with a transmission-rate assignment signal S12J. On the other hand, when the transmission-rate controlling unit 12J finds out, from the frame-kind notification signal S11J, that the data to be transmitted is notice information to be broadcasted, the transmission-rate controlling unit 12J selects a fixed transmission rate defined by the system, and then notifies the transmission processing unit 14J of the fixed transmission rate with the transmission-rate assignment signal S12J. Upon receipt of the notification of the assigned transmission rate with the transmission-rate assignment signal S12J, the transmission processing unit 14J simultaneously broadcasts the radio packets processed by the transmission-frame generating unit 11J at the assigned transmission rate.

[0008] Here, as shown in Fig. 12, notice information sets 61 to 64 are broadcasted by a base station 80 periodically in a notice-information transmission cycle 60. Each of radio terminals 91 and 92 receives a notice information set in each notice-information transmission cycle. Upon receipt of the notice information set, each of the radio terminals 91 and 92 recognizes the fact that the radio terminal can communicate with the base station. In the example shown in Fig. 12, the notice information sets 61 to 64 are sequentially broadcasted over four cycles. All of these notice information sets are transmitted at the same transmission rate, that is the minimum transmission rate, as described above. Accordingly, even when the reception environments (the radio propagation environments) of the respective radio terminals 91 and 92 are different from each other, these radio terminals 91 and 92 can accurately receive the notice information sets 61 to 64.

[0009]

[Problem to be Solved by the Invention] For the purpose of avoiding the case where the throughput of a base station exceeds the processing capacity thereof due to an

increase in the number of radio terminals selecting the base station as an access point, a method is generally employed in which the radio terminals are distributed to other base stations. In the above-described conventional radio communications system, the distribution of radio terminals is achieved by the following two methods.

[0010] The first method is one in which regulatory information for regulating the selection of a base station by a radio terminal is included in notice information broadcasted by a base station, and which causes a radio terminal to read the regulatory information when selecting a base station, so as to exclude a base station having already been selected by a number of radio terminals from the choices. For example, all or some of identifiers used for identifying radio terminals are designated at random, and then notice information including regulatory information is broadcasted together with the designated identifiers to those radio terminals, so that the use of the base station is rejected. With this method, it is possible not only to handle a radio terminal that is about to newly select a base station, but also to handle, by adjusting the regulatory information to be noticed, a radio terminal that has already been using the base station as an access point.

[0011] The second method is one in which the transmission power of a notice information packet of a base station is made variable. Specifically, this method utilizes the fact that a high transmission power output increases an area capable of receiving a packet while a low output conversely decreases the area. Accordingly, it is possible to control the total number of radio terminals distributed within an area. With this method, it is possible to perform distribution, distribution of all the radio terminals including not only radio terminals that are about to newly select a base station, but also radio terminals that have already been in use of the base station as an access point.

[0012] However, according to the first method of distributing radio terminals, each radio terminal needs to be implemented with a function of decoding regulatory information transmitted from a base station, and of then performing processing specialized for re-selecting a base station depending on the decoded information. In addition, each radio terminal is regulated regardless of the distance from the base station, or the own location of the radio terminal. For this reason, like a radio terminal located close to the base station, a radio terminal that is not keeping close enough to communicate with another base station is sometimes regulated. Once regulated, the radio terminal cannot access to the network.

[0013] In addition, according to the second method of distributing radio terminals described above, there is no need for performing processing specialized for decoding the

regulatory information. In other words, when a base station transmits a notice information set with a lower output, a radio terminal, located in a periphery of an area where a radio terminal can communicate with the base station, cannot receive the notice information set thus transmitted. Then, the radio terminal determines that the radio terminal has moved out of the area, and performs a normal handover control to seek another base station near the radio terminal. Accordingly, in the second method, unlike the case of the first method, radio terminals to be distributed are limited to those located in the periphery of the area. For this reason, it is highly possible that the radio terminals are located within an area where the radio terminals can communicate with another base station. As a result, the radio terminals will not be immediately disabled to access to the network.

[0014] However, in the second method, the transmission power of the notice information set is increased or decreased simply, while the packet length of the notice information set is not varied. For this reason, a time length when a radio medium is occupied is always constant. Accordingly, although having an effect of distributing radio terminals to other base stations, the second method does not have an effect of improving the efficiency of using a radio medium (for example, a frequency) with notice information packets. Moreover, suppose that a radio medium is shared by a plurality of base stations and radio terminals, and consider a radio access system using a carrier sensing in which a radio packet is transmitted after the usage of a medium is ascertained with the reception level (for example, the wireless LAN standard in the United States, IEEE802.11: Wireless Medium Access Control (MAC) and physical Layer (PHY) Specifications, IEEE Std 802.11, Nov. 1997.), a decrease in the transmission power of a radio packet leads to an increase in the number of radio terminals that cannot recognize that the radio medium is in use. As a result, a so-called collision problem of hidden terminals occurs, in which a radio terminal starts to transmit a packet during a base station is transmitting a notice information packet.

[0015] The present invention has been made in consideration of the above-described circumstances. An object of the present invention is to provide a data communication device, which can distribute radio terminals to other base stations without requiring the radio terminals to perform special processing when the number of radio terminals to use a specific base station as an access point is increased, and which can also improve the efficiency in using a radio medium.

[0016]

[Means for Solving the Problem] For the purpose of the above-described problems, the

present invention includes the following configuration. Specifically, a data communications device according to the present invention is a data communications device installed in a base station of a radio communications system (for example, a radio communications system shown in Fig. 4, which is to be described later) configured so that each radio terminal (for example, radio terminals 91 and 92, which are to be described later) selects, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal is set as appropriate. The data communications device is characterized by including notice-information transmitting means (for example, constituent elements corresponding to a transmission-rate controlling unit 12, a notice-information transmission-rate storing unit 13 and a transmission processing unit 14, to be described later), which broadcasts the notice information at a transmission rate in which the selection status of a base station (for example, a constituent element corresponding to a base station 80, which is to be described later) having the data communications device installed therein is reflected.

[0017] In addition, the data communications device is characterized in that the notice-information transmitting means includes: transmission-rate setting means (for example, a constituent element corresponding to a notice-information transmission-rate storing unit 13, which is to be described later), which sets a transmission rate in which the selection status of the base station is reflected; transmission-rate assigning means (for example, a constituent element corresponding to a transmission-rate controlling unit 12, which is to be described later), which acquires the transmission rate set by the transmission-rate setting means in a case where what is to be transmitted is the notice information, and which assigns the transmission rate thus acquired as a transmission rate for the notice information; and transmitting means (for example, a constituent element corresponding to a transmission processing unit 14, which is to be described later), which broadcasts the notice information at the transmission rate assigned by the transmission-rate assigning means.

[0018] Moreover, the data communications device is characterized by further including traffic measuring means (for example, a constituent element corresponding to a traffic measuring unit 23, which is to be described later), which measures the number of radio packets received by the base station having the data communications device installed therein so as to measure the amount of traffic of the base station, and which then sets, in the transmission-rate setting means, a transmission rate depending on the current amount of traffic.

[0019] Furthermore, the data communications device is characterized by further including terminal monitoring means (for example a constituent element corresponding to a managed-terminal monitoring unit 31, which is to be described later), which monitors radio terminals having selected, as an access point, the base station having the data communications device installed therein so as to find out the number of the radio terminals, and which then sets a transmission rate depending on the current number of the radio terminals in the transmission-rate setting means.

[0020] Still furthermore, the data communications device is characterized by further including notice-information monitoring means (for example, a constituent element corresponding to a neighboring-base-station transmission-rate managing unit 41), which monitors notice information transmitted from a neighboring base station so as to find out the transmission rate of the notice information, and which then sets a transmission rate depending on the current transmission rate thus found out in the transmission-rate setting means.

[0021] A data communications method according to the present invention is a data communications method adopted by a base station of a radio communications system configured so that each radio terminal selects, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal is set as appropriate. The data communications method is characterized by including (a) a first step (for example, an element corresponding to: Step STP10 shown in Fig. 2; Steps STP01, STP02 to STP10, shown in Fig. 6; Steps STP01, STP03 to STP10, shown in Fig. 8; or Steps STP01, STP04 to STP10, which are all to be described later) of setting a transmission rate in which the selection status of a base station adopting the data communications method is reflected; (b) a second step (for example, an element corresponding to Steps STP12 and STP13, shown in Fig. 2, which are to be described later) of acquiring the transmission rate set in the first step in a case where what is to be transmitted is the notice information, and of then assigning the transmission rate thus acquired as a transmission rate for the notice information; and (c) a third step (for example, an element corresponding to Step STP14 shown in Fig. 2, which is to be described later) of broadcasting the notice information at the transmission rate assigned in the second step.

[0022] In addition, the data communications method is characterized in that the first step further includes a step (for example, Steps STP01 and STP02 shown in Fig. 6, which are to be described later) of measuring the number of radio packets received by the base

station adopting the data communications method so as to measure the amount of traffic of the base station, and of then setting a transmission rate depending on the current amount of traffic.

[0023] Moreover, the data communications method is characterized in that the first step further includes a step (for example, Steps STP01 and STP03 shown in Fig. 8, which are to be described later) of monitoring radio terminals having selected, as an access point, the base station adopting the data communications method so as to find out the number of the radio terminals, and of then setting a transmission rate depending on the current number of the radio terminals.

[0024] Furthermore, the data communications method is characterized in that the first step further includes a step (for example, Steps STP01 and STP04 shown in Fig. 10, which are to be described later) of monitoring notice information transmitted from a neighboring base station so as to find out the transmission rate of the notice information, and of then setting a transmission rate depending on the current transmission rate thus found out.

[0025] A recording medium according to the present invention is a recording medium having a program recorded therein, the program having a radio communications method written therein, the radio communications method adopted by a base station of a radio communications system configured so that each radio terminal selects, on the basis of notice information broadcasted from base stations, a base station to be used as an access point, and that a transmission rate to be used for data communications between a base station and a radio terminal is set as appropriate, the program for executing: (a) a first step of setting a transmission rate in which the selection status of a base station adopting the data communications method is reflected; (b) a second step of acquiring the transmission rate set in the first step, in a case where what is to be transmitted is notice information, and of then assigning the transmission rate thus acquired as a transmission rate for the notice information; and (c) a third step of broadcasting the notice information at the transmission rate thus assigned in the second step.

[0026] Hereinafter, the operation of the present invention will be described. In general, when communications are performed with an increased transmission rate, while the communication speed is enhanced, it is necessary that the radio propagation environment between radio stations be favorable and stable. On the other hand, when communications are performed with a decreased transmission rate, while the communication speed is decreased, it is possible to adopt a radio propagation technique that is unlikely to be influenced by deterioration in the radio propagation environment, so

that a base station and a radio terminal can communicate with each other at a farther distance in between. The present invention utilizes this characteristic. When the number of radio terminals to use a base station as an access point is increased, the base station changes the transmission rate for a notice information set with which the radio terminals select a base station, so that the communication area covered by the base station is seemingly changed.

[0027] For example, when the transmission rate, a radio terminal, which is located far away out of the radio propagation environment, cannot receive notice information transmitted at the increased transmission rate so as to select a base station transmitting the notice information. Accordingly, the number of radio terminals that can use the base station as an access point. As a result, a radio terminal that cannot receive the notice information is forced to select another base station, so that radio terminals are distributed. At this time, since the transmission rate at which the notice information is transmitted from the base station is increased, the packet length of the notice information is reduced, so that a radio medium is effectively used.

[0028] Accordingly, even when the number of radio terminals each using a specific base station as an access point is increased, it is possible to distribute radio terminals to other base stations without requiring the radio terminals to perform special processing. It is concurrently possible to improve the use efficiency of radio media. In addition, since it is possible to distribute radio terminals while the transmission rate is always kept constant, the so-called problem of hidden terminals is not induced.

[0029] As described above, the constant and minimum transmission rate in a system has been conventionally used as the transmission rate for notice information, which is broadcasted from a base station to a plurality of radio terminals. On the other hand, the present invention is configured so that the transmission rate for notice information used by a radio terminal for selecting a base station is freely set, changed and controlled with a focus on the relationship between a communication speed and the stability of communications, with respect to a transmission rate, and that the transmission rate for notice information is changed

[0030]

[Embodiments of the Invention] Hereinafter, descriptions will be given of the present invention with reference to the figures. Incidentally, the same elements are denoted by the same reference numerals in each of the figures, and descriptions of those elements will not be repeated.

[0031] <Embodiment 1> Fig. 1 shows a configuration of a transmission system of a base

station in which a data communications device according to Embodiment 1 of the present invention is employed. The base station including this transmission system constitutes a radio communication system together with radio terminals connected to the base station respectively via wireless links. In this radio communications system, the base station periodically broadcasts the own operational information as notice information to all the radio terminals, while each of the radio terminals selects a base station to use as an access point on the basis of the notice information broadcasted by the base station. In addition, the transmission rate used for data communications between the base station and each of the radio terminals is set as appropriate.

[0032] In Fig. 1, notice information or user data is inputted into a transmission-frame generating unit 11 as data to be transmitted. The transmission-frame generating unit 11 processes each inputted data so that each inputted data forms a radio packet defined by the system, and outputs the processed data to a transmission processing unit 14. In addition, the transmission-frame generating unit 11 also notifies a transmission-rate controlling unit 12 of the kind of the processed data (the notice information, the user data or the like) with a frame-kind notification signal S11.

[0033] The transmission-rate controlling unit 12 assigns a transmission rate to a transmission processing unit 14 to be described later in accordance with the kind of data processed by the transmission-frame generating unit 11. For example, when the transmission-rate controlling unit 12 finds out, from the frame-kind notification signal S11, that what is to be transmitted is user data, the transmission-rate controlling unit 12 notifies the transmission processing unit 14 of a transmission rate having been set as the optimum transmission rate for communications with each radio terminal, with a transmission-rate assignment signal S12.

[0034] On the other hand, when the transmission-rate controlling unit 12 finds out, from the frame-kind notification signal S11, that what is to be transmitted is notice information to be broadcasted, the transmission-rate controlling unit 12 outputs a notice-information transmission-rate acquisition signal S13 to a notice-information transmission-rate storing unit 13 to be described later, and in turn acquires a transmission rate from the notice-information transmission-rate storing unit 13. Then, the transmission-rate controlling unit 12 assigns the acquired transmission rate to the transmission processing unit 14 as a transmission rate for the notice information, with the transmission-rate assignment signal S12.

[0035] The notice-information transmission-rate storing unit 13 sets a transmission rate, in which the selection status of the base station having the data communications device

installed therein is reflected, and which is used when notice information is broadcasted. In the notice-information transmission-rate storing unit 13, a transmission rate can be freely set from the outside by, for example, a maintenance manager of the base station. Accordingly, a transmission rate for broadcasting a notice information packet is not fixed, and it is thus possible to freely change the transmission rate in accordance with, for example, a method of maintenance.

[0036] In Embodiment 1, a single value is stored as a transmission rate for notice information in the notice-information transmission-rate storing unit 13, and the transmission rate for notice information is set again by rewriting the value from the outside. However, the configuration of the notice-information transmission-rate storing unit 13 is not limited to this. For example, a plurality of kinds of transmission rates may be set in the notice-information transmission-rate storing unit 13 in advance, and then one may be selected from these transmission rates as appropriate.

[0037] The transmission processing unit 14 transmits data processed by the transmission-frame generating unit 11. When notice information is to be transmitted, the transmission processing unit 14 broadcasts data of the notice information processed by the transmission-frame generating unit 11 at a transmission rate assigned by the transmission-rate controlling unit 12.

[0038] The transmission-rate controlling unit 12, the notice-information transmission-rate storing unit 13 and the transmission processing unit 14, which have been described above, constitute notice-information transmitting means (with no reference numeral) for broadcasting notice information at a transmission rate in which the selection status of a base station having the data communications device installed therein is reflected. Here, the "selection status of the base station" represents the status of the base station having been selected as an access point by the radio terminals, and means the amount of traffic of the base station, or the number of radio terminals each having selected the base station, for example. Alternatively, since the "selection status of the base station" is reflected in the transmission rate for notice information to be transmitted from the base station having the data communications device installed therein, the "selection status of the base station" may be found out from the transmission rate for notice information.

[0039] Hereinafter, description will be given of an operation (a data communications method) of the data communications device according to this embodiment with reference to a flowchart shown in Fig. 2.

Step STP10: A value of a transmission rate for notice information is written in the

notice-information transmission-rate storing unit 13 from the outside. In the transmission rate, the selection status of the base station is reflected. Accordingly, the more the number of radio terminals each having selected the base station as an access point is, the higher the value indicating the transmission rate is set.

[0040] Step STP11: In a state where the transmission rate is set in the notice-information transmission-rate storing unit 13, when notice information is inputted into the transmission-frame generating unit 11, the transmission-frame generating unit 11 generates a transmission frame by processing the inputted notice information so as to form a radio packet defined by the system, and then outputs the generated transmission frame to the transmission processing unit 14. In addition, the transmission-frame generating unit 11 outputs a frame-kind notification signal S11, which indicates that the kind of the processed data is notice information, to the transmission-rate controlling unit 12 so as to notify the transmission-rate controlling unit 12 of the fact that the notice information is to be transmitted.

[0041] Step STP12: Subsequently, the transmission-rate controlling unit 12 acquires the transmission rate set in the notice-information transmission-rate storing unit 13. Specifically, when the transmission-rate controlling unit 12 finds out, on the basis of the frame-kind notification signal S11 received from the transmission-frame generating unit 11, that what is to be transmitted is notice information, the transmission-rate controlling unit 12 outputs a notice-information transmission-rate acquisition signal S13 to the notice-information transmission-rate storing unit 13, so as to acquire the transmission rate set in the notice-information transmission-rate storing unit 13.

[0042] Step STP13: Then, the transmission-rate controlling unit 12 assigns the transmission rate for notice information to the transmission processing unit 14. Specifically, the transmission-rate controlling unit 12 assigns the transmission rate acquired from the notice-information transmission-rate storing unit 13, as a transmission rate for the notice information, to the transmission processing unit 14, with a transmission-rate assignment signal S12.

[0043] Step STP14: Subsequently, the transmission processing unit 14 performs transmission processing for broadcasting the notice information. Specifically, the transmission processing unit 14 broadcasts a packet including a transmission frame of the notice information, which is processed by the transmission-frame generating unit 11, at the transmission rate assigned by the transmission-rate controlling unit 12. Consequently, the notice information is broadcasted at the transmission rate set arbitrarily from the outside.

[0044] Next, descriptions will be given of a method of distributing radio terminals by the data communications device according to this embodiment, with reference to Fig. 3. As in the above-described case shown in Fig. 12, in this embodiment, notice information is transmitted by the base station periodically in the notice-information transmission cycle 60. In an example shown in the figure, three kinds of transmission rates are used as transmission rates for a notice information packet, and are denoted respectively by Rate 1, Rate 2 and Rate 3, in ascending order from the lowest transmission rate.

[0045] Firstly, a base station 80 transmits notice information 71 at Rate 1. In this case, since the transmission rate is low, the radio terminals 91 and 92 can accurately receive the notice information 71, and then find out that the radio terminals 91 and 92 can communicate with the base station 80. Accordingly, in this case, both of the radio terminals 91 and 92 select the base station 80 as an access point. Although only two radio terminals are given in this example, the base station 80 is put in a state where the base station 80 is to be selected by an unspecified number of radio terminals.

[0046] Then, when it is necessary to distribute radio terminals that select the base station 80, the base station 80 transmits notice information 72 at Rate 2. This transmission rate is set by updating the value having been set in the notice-information transmission-rate storing unit 13 from the outside. In this case, since the notice information 72 is transmitted at a higher rate than the notice information 71, the packet length of the notice information 72 is shorter than that of the notice information 71. As a result, there are some radio terminals that cannot receive the notice information 72, due to the difference in the radio propagation environment. In this example, the radio terminal 91 receives the notice information 72 while the radio terminal 92 fails to receive the notice information 72. Accordingly, the radio terminal 92 determines that the radio terminal 92 has moved out of the area of the radio terminal 80, and thus performs normal handover processing so as to select another base station.

[0047] On the other hand, when the transmission rate of the notice information 73 is set to Rate 3, which is higher than Rate 2, the packet length of the notice information 73 is shorter than the packet length of the notice information 72. Accordingly, the radio terminal 91 also fails to receive the notice information. That is, the base station 80 can cause the radio terminal 91 as well to perform a handover by transmitting the notice information 73 at Rate 3, which is higher than others. At this point, there is no radio terminal existing under control of the base station 80. However, once the base station 80 transmits next notice information 74 again at Rate 1, the possibility arises that the base station 80 is selected by other radio terminals. Consequently, it is possible to always

perform the distribution of radio terminals by changing the transmission rate. In addition, it is also possible to control the degree of the distribution of radio terminals on the basis of the value of the transmission rate.

[0048] Next, descriptions will be given of the proceeding of the above-described method of distributing radio terminals with reference to Fig. 4. The part (a) of Fig. 4 shows a state before the transmission rate for notice information is changed, and transmission rates of notice information transmitted respectively from the base station 80 and another base station 81 are both set to Rate 1. On the other hand, the part (b) of Fig. 4 shows a state after the transmission rate for notice information is changed, and the transmission rate for notice information transmitted from the base station 80 is changed to Rate 2 while the transmission rate for notice information transmitted from the base station 81 is held at Rate 2.

[0049] Each of the two base stations 80 and 81 connected to the network is a base station which can be used by each of the radio terminals as an access point. As shown in Fig. 12(a), when both of the base stations 80 and 81 transmit notice information at the transmission rate 1, there is a region where the communicable areas of the respective base stations overlap each other. In this example, the radio terminal 92 located in the overlap region and the radio terminal 84 existing in the area of the base station 80 select the base station 80. In such a case, since the amount of processing of the base station 80 is more than that of the base station 81, it is desirable to distribute the radio terminals.

[0050] As shown in the part (b) of the figure, when the transmission rate of the notice information transmitted from the base station 80 is increased, that is, when the notice information packet is transmitted at a higher rate, the communicable area of the base station 80 appears to be narrowed, and thus the overlap region as shown in the part (a) of the figure disappears. As a result, the radio terminal 92 recognizes that the radio terminal 92 has moved out of the area of the base station 80 to be outside the area. Accordingly, the radio terminal 92 performs handover processing so as to re-select an adjacent other base station 81 as an access point. Consequently, both of the radio terminals are distributed respectively to both of the base stations, so that an effective radio communications is achieved.

[0051] <Embodiment 2> Next, descriptions will be given of Embodiment 2 of the present invention with reference to Fig. 5 and Fig. 6. Fig. 5 shows a configuration of a transmission system of a base station in which a data communications device according to Embodiment 2 is employed. In this configuration, reception information of the base station is utilized for determining a transmission rate at which a notice information

packet is broadcasted. Specifically, the amount of traffic of the base station is acquired from the reception information, and is then reflected as the selection status of the base station in the transmission rate for notice information.

[0052] In Fig. 5, a reception processing unit 21 receives and processes a radio-received packet, which is inputted through a radio link. In addition, a received-data processing unit 22 performs predetermined processing on the radio-received packet thus received. The reception processing unit 21 and the received-data processing unit 22 are provided also to a conventional base station as a receiving system device.

[0053] A traffic measuring unit 23 measures the amount of traffic of a base station by measuring the number of radio packets received by the base station having the data communications device installed therein, and then sets a transmission rate depending on the current amount of traffic in the transmission-rate setting means. Note that, each of the other components shown in Fig. 5 are the same shown in Fig. 1, according to Embodiment 1 described above.

[0054] Hereinafter, descriptions will be given of the operation of Embodiment 2 with reference to a flowchart shown in Fig. 6.

Step: STP01: A radio-received packet inputted through the radio link is processed by the reception processing unit 21, and is then inputted into the received-data processing unit 22 for analyzing the received data. Here, the reception processing unit 21 notifies the traffic measuring unit 23 of the fact with a number-of-received-packets notification signal S21 each time the reception processing unit 21 receives a packet.

[0055] Step STP02: Upon receipt of the number-of-received-packets notification signal S21, the traffic measuring unit 23 analyzes the number of packets received by the base station as the amount of traffic. Then, the traffic measuring unit 23 notifies the notice-information transmission-rate storing unit 13 of a transmission rate in which the current amount of traffic is reflected, with a notice-information transmission-rate notification signal S22. Accordingly, the transmission rate depending on the current amount of traffic is set in the notice-information transmission-rate storing unit 13 as a transmission rate for notice information. At this time, the traffic measuring unit 23 controls the transmission rate so that the transmission rate is increased as the amount of traffic increases, and that the transmission rate is decreased as the amount of traffic decreases.

[0056] Steps STP10 to STP14: After that, notice information is broadcasted at the transmission rate set in the notice-information transmission-rate storing unit 13 as in the case of Embodiment 1 described above.

[0057] <Embodiment 3> Next, descriptions will be given of Embodiment 3 of the present invention with reference to Fig. 7 and Fig. 8. Fig. 7 shows a configuration of a transmission system of a base station in which a data communications device according to Embodiment 3 is employed. The transmission system of the base station according to Embodiment 3 is configured so that a managed-terminal monitoring unit 31 is provided instead of the traffic measuring unit 23 in the above-described configuration shown in Fig. 5. The managed-terminal monitoring unit 31 monitors radio terminals each having selected as an access point a base station having the data communications device installed therein to find out the number of the radio terminals, and then sets a transmission rate depending on the current number of the radio terminals in the notice-information transmission-rate storing unit 13.

[0058] The transmission system of the base station according to Embodiment 3 utilizes the reception information of the base station so as to determine a transmission rate for notice information, as in the manner of Embodiment 2 described above. However, the transmission system of Embodiment 3 is different from Embodiment 2 in that the number of radio terminals each having selected the base station as an access point is reflected in the transmission rate for notice information.

[0059] Hereinafter, descriptions will be given of the operation of Embodiment 3 with reference to a flowchart shown in Fig. 8.

Step: STP01: As in the manner of Embodiment 2 described above, a radio-received packet inputted through the radio link is received and processed by the reception processing unit 21, and then the processed packet is inputted into the received-data processing unit 22 for analyzing the received data. Here, the reception processing unit 21 finds out the identifier of the radio terminal which has transmitted the packet by using the analyzed received data, and then notifies the managed-terminal monitoring unit 31 of the identifier with a number-of-terminals notification signal S31 each time the reception processing unit 21 receives a packet.

[0060] Step STP03: Upon receipt of the number-of-received-packets notification signal S31, the managed-terminal monitoring unit 31 analyzes the identifier of the radio terminal so as to manage an increase and decrease in the number of radio terminals each using the base station as an access point. Then, the managed-terminal monitoring unit 31 notifies the notice-information transmission-rate storing unit 13 of a transmission rate of a notice information packet, with a notice-information transmission-rate notification signal S22. Accordingly, the transmission rate depending on the current amount of traffic is set in the notice-information transmission-rate storing unit 13 as a transmission

rate for notice information. At this time, the managed-terminal monitoring unit 31 controls the transmission rate so that the transmission rate is increased as the number of radio terminals increases, and that the transmission rate is decreased as the number of radio terminals decreases.

[0061] Steps STP10 to STP14: After that, notice information is broadcasted at the transmission rate set in the notice-information transmission-rate storing unit 13 as in the case of Embodiment 1 described above.

[0062] <Embodiment 4> Next, descriptions will be given of Embodiment 4 of the present invention with reference to Fig. 9 and Fig. 10. Fig. 9 shows a configuration of a transmission system of a base station in which a data communications device according to Embodiment 4 is employed. The transmission system of the base station according to Embodiment 4 is configured so that a neighboring-base-station transmission-rate managing unit 41 is provided instead of the traffic measuring unit 23 in the above-described configuration shown in Fig. 5. The neighboring-base-station transmission-rate managing unit 41 monitors notice information transmitted from a neighboring base station so as to find out the transmission rate of the neighboring base station, and then sets a transmission rate depending on the current transmission rate of the neighboring base station in the notice-information transmission-rate storing unit 13. Accordingly, information on the neighboring base station is utilized for determining a transmission rate for a notice information packet.

[0063] Hereinafter, descriptions will be given of the operation of Embodiment 4 with reference to a flowchart shown in Fig. 10.

Step STP01: As in the manner of Embodiment 2 described above, a radio-received packet inputted through the radio link is received and processed by the reception processing unit 21, and then the processed packet is inputted into the received-data processing unit 22 for analyzing the received data. Here, the reception processing unit 21 determines whether or not data transmitted from a neighboring base station is notice information by using the analyzed received data. Then, when the data is notice information, the reception processing unit 21 notifies the neighboring-base-station transmission-rate managing unit 41 of the transmission rate of the notice information packet, with a neighboring-base-station transmission-rate notification signal S41.

[0064] Step STP03: Upon receipt of the neighboring-base-station transmission-rate notification signal S41, the neighboring-base-station transmission-rate managing unit 41 analyzes the transmission rate of the notice information packet of the neighboring base station so as to find out the current status of the neighboring base station in terms of the

control of distributing radio terminals. Then, the neighboring-base-station transmission-rate managing unit 41 notifies the notice-information transmission-rate storing unit 13 of a transmission rate of a notice information packet, with notice-information transmission-rate notification signal S22. Accordingly, the transmission rate depending on the current transmission rate is set in the notice-information transmission-rate storing unit 13 as a transmission rate of notice information. At this time, the neighboring-base-station transmission-rate managing unit 41 controls the transmission rate so that the transmission rate is increased when the neighboring base station is using a low transmission rate, and that the transmission rate is decreased when the neighboring base station is using a high transmission rate.

[0065] Steps STP10 to STP14: After that, notice information is broadcasted at the transmission rate set in the notice-information transmission-rate storing unit 13 as in the case of Embodiment 1 described above.

[0066] According to the configuration of Embodiment 4, it is possible to distribute radio terminals with the mutual interaction between a plurality of base stations. In Embodiment 4, the information on the transmission rate used by the neighboring base station is acquired by directly receiving the notice information packet. However, the present invention is not limited to this. For example, in the case of a configuration as shown in Fig. 4, it is also possible to exchange information on a transmission rate of a base station and the like via a network between base stations. However, it should be noted that a dedicated signal to be sent through the network for the information exchange needs to be defined in this case.

[0067] In addition, according to the above-described embodiments, it is possible to eliminate the need for providing a specialized function to each radio terminal, in a method of distributing radio terminals to other base stations for the purpose of avoiding a case where the number of radio terminals each using a certain base station as an access point increases to a level beyond the processing capacity of the certain base station.

[0068] Moreover, according to the above-described embodiments, in the case of distributing radio terminals by reducing an area where a radio terminal can communicate with a base station, the transmission rate, at which notice information is transmitted, is changed to a higher transmission rate. Accordingly, it is possible to shorten the packet length of notice information, so that a time length when a radio medium is occupied by the packet is reduced. At this time, since the transmission output is always constant, the problem of hidden terminals is unlikely to occur, thus preventing a collision of radio packets from being induced.

[0069] Accordingly, the using of the data communications device according to the embodiments of the present invention makes it possible to improve the efficiency in using a radio medium (for example, a frequency) as well as to achieve distribution of radio terminals, without providing any new function to a radio terminal.

[0070] Although, descriptions have been given above of Embodiments 1 to 4 of the present invention, the present invention is not limited to these embodiments, and it is possible to embrace various modifications in design and the like, without departing from the essential matter of the present invention. For example, in each of the above-described embodiments, the transmission rate for notice information is configured to be set in the notice-information transmission-rate storing unit 13. Alternatively, it is also possible to employ a configuration, in which the transmission-rate controlling unit 12 incorporates the function of the notice-information transmission-rate storing unit 13, and in which the transmission rate is directly set in the transmission-rate controlling unit 12.

[0071] In addition, in each of the above-described embodiments, after the transmission rate is set (step STP10), the transmission frame is generated (step STP11), and then the transmission rate is acquired and assigned (steps STP12 and STP13). The order of these steps is not limited to this, and may be replaced with one another as appropriate.

[0072] Moreover, in each of the above-described embodiments, the present invention is achieved on hardware that is the data communications device. However, the present invention is not limited to this case, and may be achieved on software. In this case, it is possible to build the data communications device and the method according to the present invention, by reading in a computer a program for executing steps, which are performed by the data communications device in each of the above-described embodiments. Furthermore, by recording this program in a computer-readable recording medium, it is also possible to build the data communications and the method according to the present invention on any computer that can access the recording medium.

[0073]

[Effect of the Invention] As described above, according to the present invention, notice information is broadcasted at the transmission rate in which the selection status of a base station by radio terminals is reflected. Accordingly, when the number of radio terminals each using a specific base station as an access point increases, it is possible to distribute the radio terminals to other base stations without requiring the radio terminals to perform special processing, as well as to improve the efficiency in using a radio medium.

[0074] In addition, a transmission rate in which the selection status of a base station is reflected is set. When what is to be transmitted is notice information, a transmission rate having been set in the transmission-rate setting means is acquired and is then assigned as the transmission rate for the notice information, and consequently the notice information is broadcasted at the assigned transmission rate. This makes it possible to broadcast notice information at a transmission rate in which the selection status of a base station by radio terminals is reflected.

[0075] Moreover, the amount of traffic of a base station is measured by measuring the number of radio packets received by the base station. Then, a transmission rate depending on the current amount of traffic is set as the transmission rate for the notice information. Accordingly, when the amount of traffic of a specific base station increases, it is possible to distribute radio terminals to other base stations.

[0076] Furthermore, radio terminals each having selected a base station as an access point is monitored, so that the number of the radio terminals is found out. Accordingly, when the number of radio terminals each using a specific base station as an access point increases, it is possible to distribute radio terminals to other base stations.

[0077] Still furthermore, notice information transmitted from a neighboring base station is monitored, so that the transmission rate of the base station is found out. Then, a transmission rate depending on the current transmission rate is set as the transmission rate for the notice information. Accordingly, it is possible to distribute radio terminals in accordance with the selection status of the neighboring base station.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a block diagram showing a configuration of a data communications device according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a flowchart showing an operational flow of the data communications device according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a diagram for explaining a concept of a method of distributing radio terminals by the data communications device according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is diagrams for explaining a state where radio terminals are distributed by the data communications device according to Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a block diagram showing a configuration of a data communications device according to Embodiment 2 of the present invention.

[Fig. 6] Fig. 6 is a flowchart showing an operational flow of the data

communications device according to Embodiment 2 of the present invention.

[Fig. 7] Fig. 7 is a block diagram showing a configuration of a data communications device according to Embodiment 3 of the present invention.

[Fig. 8] Fig. 8 is a flowchart showing an operational flow of the data communications device according to Embodiment 3 of the present invention.

[Fig. 9] Fig. 9 is a block diagram showing a configuration of a data communications device according to Embodiment 4 of the present invention.

[Fig. 10] Fig. 10 is a flowchart showing an operational flow of the data communications device according to Embodiment 4 of the present invention.

[Fig. 11] Fig. 11 is a block diagram showing a configuration of a base station according to a conventional technique.

[Fig. 12] Fig. 12 is a diagram for explaining a method of transmitting a notice information packet (an operation of a conventional device) according to the conventional technique.

[Explanation of Reference Numerals]

11 transmission-frame generating unit
12 transmission-rate controlling unit
13 notice-information transmission-rate storing unit
14 transmission processing unit
21 reception processing unit
22 received-data processing unit
23 traffic measuring unit
31 managed-terminal monitoring unit
41 neighboring-base-station transmission-rate managing unit
60 notice-information transmission cycle
61 to 64, 71 to 71 notice information
80, 81 base station
91, 92 radio terminal
S11 frame-kind notification signal
S12 transmission-rate assignment signal
S13 notice-information transmission-rate acquisition signal
S21 number-of-received-packets notification signal
S22 notice-information transmission-rate notification signal
S31 number-of-terminals notification signal
S41 neighboring-base-station transmission-rate notification signal

STP10 to STP14, STP01 to STP04 step

Continued from the front page

F term (reference)	5K033	AA03	CB01	CB06	CB13	DA03
		DA19	DB18	EA06	EA07	
	5K067	AA11	BB21	CC08	EE02	EE10
		EE22	EE72	GG04	GG11	

FIG. 1

NOTICE INFORMATION

USER DATA

SET TRANSMISSION RATE FOR NOTICE INFORMATION

11 TRANSMISSION-FRAME GENERATING UNIT

12 TRANSMISSION-RATE CONTROLLING UNIT

13 NOTICE-INFORMATION TRANSMISSION-RATE STORING UNIT

14 TRANSMISSION PROCESSING UNIT

S11 FRAME-KIND NOTIFICATION SIGNAL

S12 TRANSMISSION-RATE ASSIGNMENT SIGNAL

S13 NOTICE-INFORMATION TRANSMISSION-RATE ACQUISITION SIGNAL

FIG. 2

START

STP10 SET TRANSMISSION RATE

STP11 GENERATE TRANSMISSION FRAME OF NOTICE INFORMATION

STP12 ACQUIRE TRANSMISSION RATE THUS SET

STP13 ASSIGN TRANSMISSION RATE FOR NOTICE INFORMATION

STP14 PROCESS TRANSMISSION OF NOTICE INFORMATION

END

FIG. 3, FIG. 12

60: NOTICE-INFORMATION TRANSMISSION CYCLE

71, 72, 73, 74 (61, 62, 63, 64): NOTICE INFORMATION

80: BASE STATION

91, 92: RADIO TERMINAL

RATE 1, 2

COMMUNICATABLE

HANDOVER

TIME

FIG. 4 (a), (b)

NETWORK

RATE 1, 2

80, 81 BASE STATION

HANDOVER

FIG.5

(RADIO-RECEIVED PACKET)

RECEIVED DATA

21 RECEPTION PROCESSING UNIT

22 RECEIVED-DATA PROCESSING UNIT

23 TRAFFIC MEASURING UNIT

S21 NUMBER-OF-RECEIVED-PACKETS NOTIFICATION SIGNAL

S22 NOTICE-INFORMATION TRANSMISSION-RATE NOTIFICATION SIGNAL

FIG. 6

STP01 PROCESS RECEPTION

STP02 MEASURE AMOUNT OF TRAFFIC

STP10 SET TRANSMISSION RATE

STP11 GENERATE TRANSMISSION FRAME

STP12 ACQUIRE TRANSMISSION RATE

STP13 ASSIGN TRANSMISSION RATE

STP14 PROCESS TRANSMISSION

FIG. 7

31 MANAGED-TERMINAL MONITORING UNIT

S31 NUMBER-OF-TERMINALS NOTIFICATION SIGNAL

FIG. 8

STP03 FIND OUT NUMBER OF RADIO TERMINALS

FIG. 9

41 NEIGHBORING-BASE-STATION TRANSMISSION-RATE MANAGING UNIT

S41 NEIGHBORING-BASE-STATION TRANSMISSION-RATE NOTIFICATION SIGNAL

FIG. 10

STP04 FIND OUT TRANSMISSION RATE OF NEIGHBORING BASE STATION

FIG. 11

11J TRANSMISSION-FRAME GENERATING UNIT

12J TRANSMISSION-RATE CONTROLLING UNIT

14J TRANSMISSION PROCESSING UNIT

S11J FRAME-KIND NOTIFICATION SIGNAL

S12J TRANSMISSION-RATE ASSIGNMENT SIGNAL